# ACHIEVEMENT IN ARITHMETIC COMPUTATION: ANALYSIS OF SCHOOL DIFFERENCES AND IDENTIFICATION OF AREAS OF LOW ACHIEVEMENT

by

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In his study of the curricula of residential schools for the blind, Quimby (6) noted the considerable differences among times allotted in the schools for the study of arithmetic. Such time differentials are quite possibly related to achievement differences among schools which were earlier discribed by Hayes (4). In the literature, such achievement problems have been explained as the result of the inherent difficulty of arithmetic computation for the blind (3, 4) and indicative of the need for emphasis within the curriculum upon arithmetic of practical use for the blind (1, 3).

An earlier paper (5) described results of the use of a new Braille adaptation of the Arithmetic Computation Test of the Stanford Achievement Tests. These same data make possible an elementary analysis of differences in achievement between schools in this area as well as a tentative identification of types of problems for which achievement is low. Evaluation of the implications of these data for education of the blind in arithmetic computation is beyond the author's experience. However, it is hoped that description of the data and such elementary analyses as are presented may be of assistance to educators of the blind in evaluating their own programs.

## PROCEDURE:

The Arithmetic Computation Test was administered to children attending nine residential schools for the blind. The Primary Level Test was taken by 77 children in grade 3.2; the Elementary Level Test by 70 children in grade 4.2; the Intermediate Level Test by 57 children in grade 6.2; and the Advanced Level Test by 78 children in

NOTE: Miss Angela Settle, Research Assistant, Department of Educational Research, assisted the author in scoring the tests and analysing the data utilized in this study.

grade 8.2. For a complete description of these tests and their previous use, the reader is referred to the earlier article by Nolan and Ashcroft (5).

## DIFFERENCES AMONG SCHOOLS:

Mean Achievement scores for the several schools are presented in Table I.

(INSERT TABLE I)

Whether the differences between these means are the result of random sampling fluctuations or indicate real achievement differences can be answered through the technique of analysis of variance as described by Guilford (2). For each test level the probability was far less than one in one-hundred that such differences could occur by chance alone. Therefore, we may conclude that real differences in achievement in arithmetic computation exist between the schools. Of interest also are the ranges of differences between children in the same grade. Children in grade 3.2 ranged in achievement from grade 1.9 to 2.9, those in grade 4.2 ranged in achievement from grade 2.2 to 4.0, children in grade 6.2 ranged from grade 4.1 to 5.9; and those in grade 8.2 ranged from grade 5.3 to 9.7.

Another question of interest is do schools who score high at one level score high at the others, or, conversely, do those who score low at one level score low at the other levels. Data for answering this question are presented in Table II.

(INSERT TABLE II)

This table gives the rankings from high to low at each test level for the seven schools who had means available for all levels. If achievement levels are stable within schools as a result of local conditions, we would expect a school scoring high at any one level to score high on other levels, and schools scoring low at any one level to score low on the other test levels. Examination of Table II reveals that all but two schools do remain at approximately the same relative level of achievement. However, are these relationships statistically reliable? Analysis of the data using the Kruskal-Wallis Test (7) indicate the chances are less than five in one-hundred that the relative position of the schools for all levels are the result of chance. Therefore, we can say that schools do tend to retain the same relative position for all four levels of the test.

## TABLE I

Mean Achievement Scores* at Each Test Level for Several Residential Schools for the Blind

| | | TEST LEVEL | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SCHOOL | N | PRIMARY (Grade 3.2) Mean** | N | ELEMENTARY (Grade 4.2) Mean** | N | INTERMEDIATE (Grade 6.2)** Mean** | N | ADVANCED (Grade 8.2) Mean** |
| A | 10 | 2.6 | 10 | 3.6 | 5 | 5.0 | 5 | 7.1 |
| B | 4 | 2.7 | 4 | 3.2 | *** | | *** | |
| C | 7 | 2.2 | 9 | 3.5 | 6 | 5.2 | 4 | 9.7 |
| D | 5 | 2.6 | 7 | 3.8 | 8 | 5.9 | 6 | 8.3 |
| E | 16 | 2.9 | 13 | 4.0 | 10 | 5.7 | 8 | 8.3 |
| F | 7 | 1.9 | 8 | 2.2 | 7 | 4.4 | 12 | 5.3 |
| G | 10 | 2.6 | 9 | 3.5 | 10 | 4.1 | 14 | 7.0 |
| H | 9 | 2.1 | 5 | 3.3 | 6 | 4.2 | *** | |
| [illegible] | 10 | 2.9 | 8 | 3.7 | 6 | 4.3 | 12 | 6.3 |

* Based on Total-Group Grade Norms

** Differences between these means are statistically significant at the .01 level of confidence

*** Schools having fewer than 4 pupils at any level were omitted

## TABLE II

### Comparison of Schools* for Stability of Differences over all Four Levels of the Test

| | SCHOOL | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | C | D | E | F | G | I |
| TEST LEVEL | SCHOOL RANK | | | | | | |
| Primary | 4 | 6 | 3 | 1 | 7 | 5 | 2 |
| Elementary | 4 | 6 | 2 | 1 | 7 | 5 | 3 |
| Intermediate | 4 | 3 | 1 | 2 | 5 | 7 | 6 |
| Advanced | 4 | 1 | 2 | 3 | 7 | 5 | 6 |

* Schools lacking means at any one level were omitted

A third question --- Does progress occur at the same rate within each school?--- can be only tentatively answered from the present data. Evidence that it does not is presented in Figure 1. This figure graphically indicates the spread of the achievement means for the schools at each grade level. At grade 3.2 the achievement means are grouped closely together, indicating near common achievement for the schools. As you go up the grades, however, the spread of means becomes increasingly greater demonstrating that some schools are progressing rapidly and that some are lagging. For example, comparison of means for grades 6.2 and 8.2 shows that achievement in some sixth grades surpasses that of one eighth grade.

(INSERT FIGURE I)

The above analyses reveal that real and sometimes considerable differences in achievement in arithmetic computation exist between the schools participating in this study. The why of these differences is not apparent from the data. It is suggested that these differences are the result of the interaction of a number of complex factors. These may include type of arithmetic instruction given, amount of time devoted to it, intellectual characteristics of student groups, policy concerning public school attendence of blind children within a state, quality of instruction, and others. This list is not all-inclusive, nor may all these factors be operant within a given school. If these schools are taken as a representative sample of all such schools in our country, it appears that increased emphasis on arithmetic computation in some schools should be considered.

## ARITHMETIC AREAS OF LOW ACHIEVEMENT:

Areas of low achievement (types of problems) were identified through examination of item difficulties. An item difficulty for this study was defined as the ratio of the number of pupils passing an item to the total number of pupils taking the test. If fewer than 40% of pupils taking the test answered problems of a specific type correctly, the arithmetic area is considered one of low achievement. Since the tests at each level cover more than one grade, pupils may score low simply because the material in that area is inappropriate for the pupils' grade. However, it is

believed educators will have little difficulty in identifying such areas. Areas of low achievement identified were as follows:

1. Grade 3.2, Primary Battery:
    - (a) Addition or subtraction where it is necessary to carry a number from the unit's to the ten's column
    - (b) Addition or subtraction involving numbers of more than two digits
    - (c) Addition of decimals
    - (d) Any type multiplication
    - (e) Any type division
2. Grade 4.2, Elementary Battery:
    - (a) Addition of more than two numbers, when numbers with more than two digits are involved
    - (b) Subtraction of numbers having more than two digits
    - (c) Division and multiplication, when numbers of greater than one digit are involved
    - (d) Any operation involving decimals
    - (e) Fractions
3. Grade 6.2, Intermediate Battery:
    - (a) Any operation involving fractions
    - (b) Any operation involving decimals
    - (c) Problems where units of measure (feet or pounds) are involved
    - (d) Reading graphs that present more than one set of data
4. Grade 8.2, Advanced Battery:
    - (a) Problems related to interest on investments
    - (b) Reading graphs that present more than one set of data
    - (c) Problems involving negative numbers
    - (d) Algebraic problems

## SUMMARY:

Data from an earlier study of a Braille adaptation of the Arithmetic Computation Tests of the Stanford Achievement Tests were analysed in order to study differences in achievement among schools and identify types of problems for which achievement is low.

It was found that statistically significant differences in arithmetic computation achievement exist between schools, and that schools are relatively stable in their levels of achievement. Different rates of progress in achievement in this area appear to exist among schools.

Types of problems for which achievement of blind children is low were tentatively identified.

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